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NOTES ON THE BIOGEOGRAPHY AND NATURAL HISTORY OF THE ORBWEAVING SPIDER *CAREPALXIS* (ARANEAE, ARANEIDAE), INCLUDING A GUMNUT MIMIC FROM SOUTHWESTERN AUSTRALIA

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ABSTRACT. The biogeography of the Gondwanan orbweaving spider *Carepalxis* is reviewed. The genus occurs in Central and northern South America, Australia and New Guinea. It is recorded for the first time from Western Australia. Mimicry of a gumnut (eucalypt seed capsule) is described and illustrated for a southwestern Australian species. It is postulated that the mimicry protects the spiders from bird predation.

The Australian spider fauna includes a significant Gondwanan component. Even amongst taxonomically rich, cosmopolitan families such as the Araneidae, there are some genera with characteristic Gondwanan geographic ranges. The orbweaving genera *Pararaneus* Caporiacco 1940 and *Carepalxis* L. Koch 1872 are examples. *Pararaneus* (like the mygalomorph Paramiginae) is distributed in Africa and Australia where it is possibly confined to southwestern Western Australia (Main unpubl. data). *Carepalxis* (as with the mygalomorph Actinopodidae, Goloboff & Platnick 1987) occurs in Central and South America and Australia (Levi 1992; Bonnet 1956; Roewer 1942) and New Guinea (Chrysanthus 1961; Brignoli 1983).

Within Australia, *Carepalxis* has been recorded previously only from eastern Australia. Some years ago in southwestern Australia I observed an interesting specimen of *Carepalxis* which appeared to mimic a gumnut (seed capsule of a eucalypt) and this aroused my interest in the genus. Prior to this and more recently the Western Australian Museum has acquired a small collection of specimens of *Carepalxis* comprised of several species from widely scattered localities in Western Australia.

This paper presents preliminary remarks on the systematics and biogeography of Australian *Carepalxis* species, records for the first time the occurrence of the genus in Western Australia, and describes the natural history and the apparent mimicry of a southwestern Australian species.

SYSTEMATICS AND BIOGEOGRAPHY

Carepalxis L. Koch

Carepalxis L. Koch 1872: 123. Type species by monotypy *C. montifera* L. Koch 1872: 123. Holotype female from Mackay, Queensland, Australia, originally in Godeffroy Museum, now in Zoologisches Institut and Museum, Hamburg (not examined). *Carepalxis*: Davies 1988: 300, Pl. 22. *Carepalxis*: Levi 1992: 252.

See also Bonnet (1956), Roewer (1942) and Brignoli (1983) for species lists and synonymies.

Comments.—Levi examined the type of *montifera* and reported that it has a shrivelled abdomen and that the scape of the epigynum was torn off (Levi 1992). Davies (1988) illustrated a specimen, including the epigynum, which she identified as *C. tuberculata* Keyserling.

Diagnostic notes.—The most characteristic feature of *Carepalxis* is the pair of large humps on the carapace of the female. These have the appearance of two subdued horns (see Davies 1988). As stated by Levi (1992) *Gasteracantha* also has carapace humps but they are much smaller. The abdomen is often tuberculate, is high in the front and overhangs the carapace where it fits snugly into the space behind the caput humps. The epigynum in Australian species is basally broad with a short, pointed or long, finger like scape hinged at the front then directed backwards (see Davies 1988). Levi (1992) redescribed the males

identified by Simon (1896) as of *C. tuberculatua* Keyserling and noted that the carapace had only slight swellings in place of the humps of the female. Other features of the male included concave chelicerae associated with a large palpus, a single macroseta on the palpal patella, a tooth on the endite, and a hook on the first coxa. He also gave some details of the palpal organ. Davies (1988) had earlier stated that many "unmatched" males of *Carepalxis* were known and included male features such as the spur ("hook" of Levi) on coxa I and a single spine ("macroseta" of Levi) on the palpal patella in her generic key of Australian orbweaving spiders.

Biogeography and taxonomy of species.—Levi (1992) recognized three species from Central and South America in his review of the American species. There are currently eight species recognized from Australia and two from New Guinea (Roewer 1942; Bonnet 1956; Chrysanthus 1961).

The occurrence of *Carepalxis* in Australia and Central and South America but not in Africa parallels that of the South American *Taczanowskia* Keyserling 1879 and the Australian *Celaenia* Thorell 1868 (the latter also occurs in New Zealand) which are regarded as sister genera (Simon 1895; Eberhard 1981; Levi 1996). Such a geographic disjunction suggests that *Carepalxis* was established as a genus at least by the early Tertiary before the separation of South America and Australia but after the breakaway of Africa post-Jurassic.

All currently recognized Australian species (Bonnet 1956; Roewer 1942; Brignoli 1983) are from eastern Australia. All types are females and their localities and depositions follow. *Carepalxis beelzebub* (Hasselt) 1873, Melbourne Victoria, Amsterdam Netherlands; *C. bilobata* Keyserling 1886, Peak Downs Queensland, Museum Godeffroy now in Zoologisches Institut und Museum (ZMH) Hamburg); *C. coronata* (Rainbow) 1896, New England New South Wales, Australian Museum (AM) Sydney; *C. furcula* Keyserling 1886, Peak Downs, Queensland, ZMH; *C. lichensis* Rainbow 1916, Gordonvale, Queensland, AM; *C. montifera* L. Koch 1872, Mackay, Queensland, ZMH; *C. poweri* Rainbow 1916, Narabeen New South Wales, AM; *C. tuberculata* Keyserling 1886, Sydney New South Wales, Rockhampton and Peak Downs Queensland, ZMH.

Figure 1.—Distribution of *Carepalxis* in Western Australia.

Of the American species, Levi (1992) considered *C. camelus* Simon from Paraguay and Argentina to be the most similar to the type species, *C. montifera* from Queensland, Australia. This opinion appeared to be based on similarity of the long scape of the epigynum of *C. camelus* and illustrations by Davies of a specimen identified by her as *tuberculata.*

Records of Carepalxis from Western Australia: Carepalxis is now recorded from Western Australia for the first time. There are 44 specimens of the genus in the Western Australian Museum and three in my collection (BYM) held at the Zoology Department, University of Western Australia. These appear to belong to seven species, three of which show similarities to *C. tuberculata*, *C. furcula* and *C. beelzebub*. Locality records are indicated on the map in Fig. 1 showing the scattered, wide distribution in Western Australia from the tropics and arid interior to the mesophytic and coastal southwest.

The apparent central gap in the continental distribution is anomalous. Although there is a tendency to think of Gondwanan distributions as pertaining to southern Australia (and there are many such relictual distributions), clearly some Gondwanan genera occur also in the tropics and even arid regions. Within the Araneidae, *Celaenia* Thorell (sister genus of the South American *Taczanowskia* Keyserling) has a continental distribution, including arid habitats. Considering the wide (although apparently disparate) geographic range of *Carepalxis* on both "sides" of the Australian con-

tinent it would be expected to range also from Darwin to Adelaide through the center.

NATURAL HISTORY OBSERVATIONS AND DISCUSSION

Predation.—Thirty of the 44 specimens of *Carepalxis* in the WAM collection were found in dissected mud wasp nests. Twenty-eight of these, from Sabina River near Busselton, were from eight nests (which also included other Araneids) made by solitary wasps of a *Polis* sp. (J. Waldock pers. comm.). Of the other two specimens, one from Kathleen Valley was reported by the collector to have come from "a hornet's nest packed with spiders," the other from Darlington (near Perth) was recorded as "prey of a wasp." It is well known that various mud-dauber pompilids prey on araneid spiders which they seek out while the spiders are resting during the day. Also of interest and direct relevance is Rainbow's record of a specimen of *Carepalxis bilobata* Keyserling 1886 "from nest of *Scelephron* sp." from Cooktown, Queensland (Rainbow 1916). Other predators probably include birds such as honeyeaters which are well known for their habit of searching out spiders as prey.

Mimicry and web.—On 24 May 1980 in West Cape Howe National Park I was surprised to observe a specimen of a *Carepalxis* species sitting among some buds of a jarrah tree (*Eucalyptus marginata* Donn. ex Sm.) (see Main 1988 for description of the site). The spider was unnoticed, until it flexed and retracted its legs. This was due to its striking resemblance to the seed capsules (gumnuts) borne abundantly on the jarrah tree along with developing flower buds. This resemblance resulted from the shape and colour of the spider's abdomen. The "folium" or leaf pattern on the back of the abdomen was much darker than the general background color. The folium was not posteriorly attenuated as in many araneids such as *Araneus* Clerck 1757 and *Eriophora* Simon 1864 species, but was longitudinally compressed and roughly circular in outline. This, combined with the characteristic squat and dorsally flattened shape of the abdomen, presented in profile an urn shape (like a smooth-walled, woody jarrah "nut") and dorsally the dark, truncated pseudo-folium resembled the opening of the nut from which the seeds are shed (Figs. 2, 3 & 4).

Web construction: The spider was kept alive in the laboratory for a month to observe its behavior. Dry jarrah twigs with gumnuts were stood in a small container of soil and over these was placed a large glass battery jar (18 × 20 × 28cm). The spider constructed a horizontal line between the ends of two terminal twigs and hung suspended from the line each night for 15 nights. The spider appeared to hold the thread with the first legs outstretched in front and with the fourth legs stretched behind. Legs 2 and 3 were bent close to the body but also held the thread. It varied its position at either end of the thread on different nights. The first day after constructing the thread the spider rested on the floor of the cage. Thereafter, when away from the thread it took up a position against a gumnut to which it showed a remarkable resemblance. After 15 days the spider constructed, during one night, a complete vertical orbweb and hung suspended upside down at the hub. The sticky spiral began some distance from the hub which appeared to be "open." It is remarkable that the spider was able to construct the web in the absence of any appreciable air currents below the battery jar.

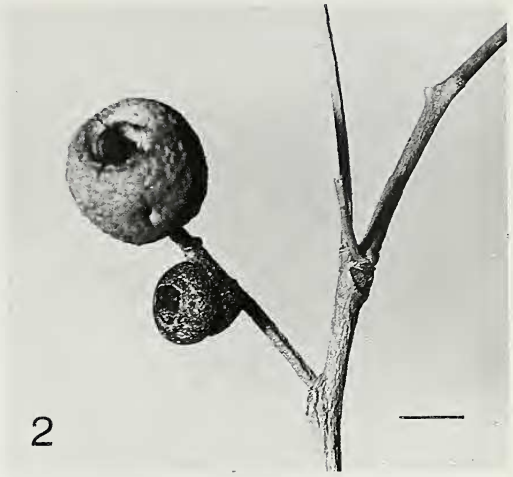
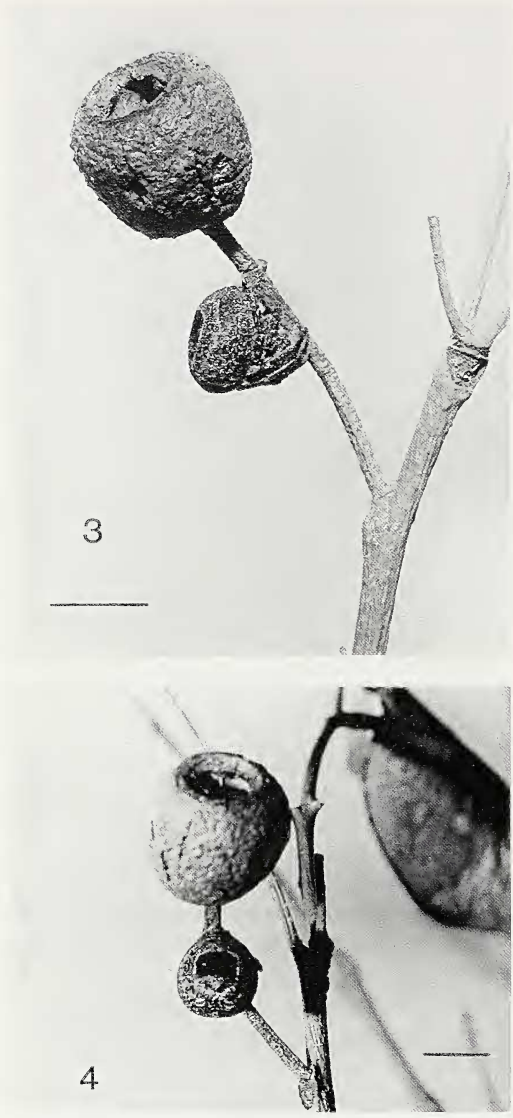


Figure 2.—Jarrah "nut" (seed capsule) and *Carepalxis* mimic, oblique profile view. (Scale bar = 5.0 mm).

There are few references to the web of *Carepalxis*. However, Rainbow (1909) referred to the typical "orbicular" web of *C. tuberculata*. Rainbow (1916) also described (from a collector's notes) three spherical egg cocoons of



Figures 3, 4.—Jarrah "nut" and *Carepalxis* mimic "perched" on stem below nut. 3. Profile view of spider; 4. Dorsal view (or "rear" view of abdomen) of spider. (Scale bars = 5.0 mm).

Carepalxis lichensis Rainbow 1916, "suspended in a horizontal line in forest tree."

Mimicry in araneid spiders: Over a century ago Rainbow (1896) in his dissertation on protective coloration and mimicry of spiders cited several examples of mimicry in Australian Araneidae. These included "mimicry" and concealment of egg cocoons. However, most examples were of spiders fitting one of the following three categories. (1) Those which resembled parts of plants through a combination of color and pattern; such mimicry was interpreted as helping the spiders to avoid attack by birds and reptiles. Rainbow listed the following instances in this category: *(a) Epeira ficta* (= *Araneus fictus* (Rainbow 1896)) and *E. similaris* (= *Zealaranea crassa* (Walckenaer 1842)) which "mimics" leaves exhibiting patterns of holes caused by insect attack. *(b) Acrosoma* Perty 1833, which bears a likeness to thorny leaves and "knots" of shrubs. *(c) Tetragnatha* Latreille 1804, *Phonognatha* Simon 1894, and *Epeira higginsii* L. Koch 1871 (= *Arachnura higginsii* (L. Koch)) (all at that time included in the Argiopidae (= Araneidae)) which have a likeness to twigs and/or leaves. Not mentioned by Rainbow is the notable blend of *Dolophones* Walkenaer 1837 with twigs around which it wraps the broad, flattened abdomen thereby eluding visual detection. (2) Those spiders which bear a likeness to insects that are unpalatable to birds (i.e., Batesian mimicry), e.g., *Cyrtarachne caliginosus* (Rainow 1894) (= *Ordgarius furcatus* O.P. Cambridge 1877)) in which the male has hairs that mimic in appearance the irritating hairs of certain caterpillars. (3) Those spiders which attract insect prey, e.g., *Celaenia excavata* (L. Koch 1867) which through its resemblance to a bird dropping, Rainbow suggested lured potential insect prey in "quest of food."

"Gumnut" mimicry as protection against predators: There do not seem to be documented examples of araneids with such precise specific plant models as that of the "gumnut" *Carepalxis* recorded here, the advantage of which is assumed to be protection against bird predators. In this light it is of interest that four of the *Carepalxis* specimens in the WAM collections found in dissected wasp nests show a remarkable similarity to the West Cape Howe gumnut mimic. The specimens are not in ideal condition and some are shrivelled but show a distinctly dark, modified folium roughly circular in outline on a lighter ground. In that such wasps are diurnal hunters the spiders must have been searched out while resting rather than when exposed in a web. Hence although the mimicry may protect the spiders from birds such as honeyeaters which are very persistent in their foraging amongst foliage, clearly some wasps are able to detect them.

Development of "gumnut" mimicry.—Many araneid genera, e.g., *Araneus* Clerck 1857 and *Eriophora* Simon 1864 have a leaf-like (folium) pattern on the dorsum of the abdomen. The folium margin is frequently stencilled and the folium itself may be a different color to the background color of the integument. Some species exhibit a distinct polymorphism for color patterns which may be fixed throughout life. For example, *E. biapicata* (L. Koch 1871) shows a range of color combinations through greys and browns of folium and background, with the folium toning or contrasting with the abdomen background color. Some individuals appear to lack pigment in the folium area with the guanin deposits showing through the integument as a white folium patch or arrowhead (see Main 1976, Pl. 36; as *Araneus transmarinus* (Keyserling 1865)).

Spiders rest away from their webs during the day on foliage, seed heads, bark and buildings. Matching colors of spiders and background is often striking. Nevertheless it is doubtful whether these spiders can change color abruptly or at all after the first few instars. It is more likely that selection occurs on spiderlings during their early instars. However, there is certainly scope for manipulation and experimentation with spiderlings on different backgrounds to test colour modification.

Species of *Carepalxis* possibly exhibit color variations amongst individuals like other araneids, particularly *Eriophora*. Thus selection could favor those individuals with a dark abdominal patch (gumnut mimics) which would be less conspicuous to birds (at least for spiders hosted in jarrah foliage). The questions to ask now are: Is there variation in initial color patterns within cocoon clutches? If so, is there selection according to differential foliage settlement, i.e., on jarrah versus other vegetation in relation to color pattern (gumnut versus non-gumnut mimics)?

Observations and museum collections suggest that *Carepalxis* spiders, of any design, although geographically widespread, are rare. Such perceived rarity poses real difficulties for a biologist's analysis of the mimicry. However, the wasps know otherwise!

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